High resolution data assimilation in the GLORI Project

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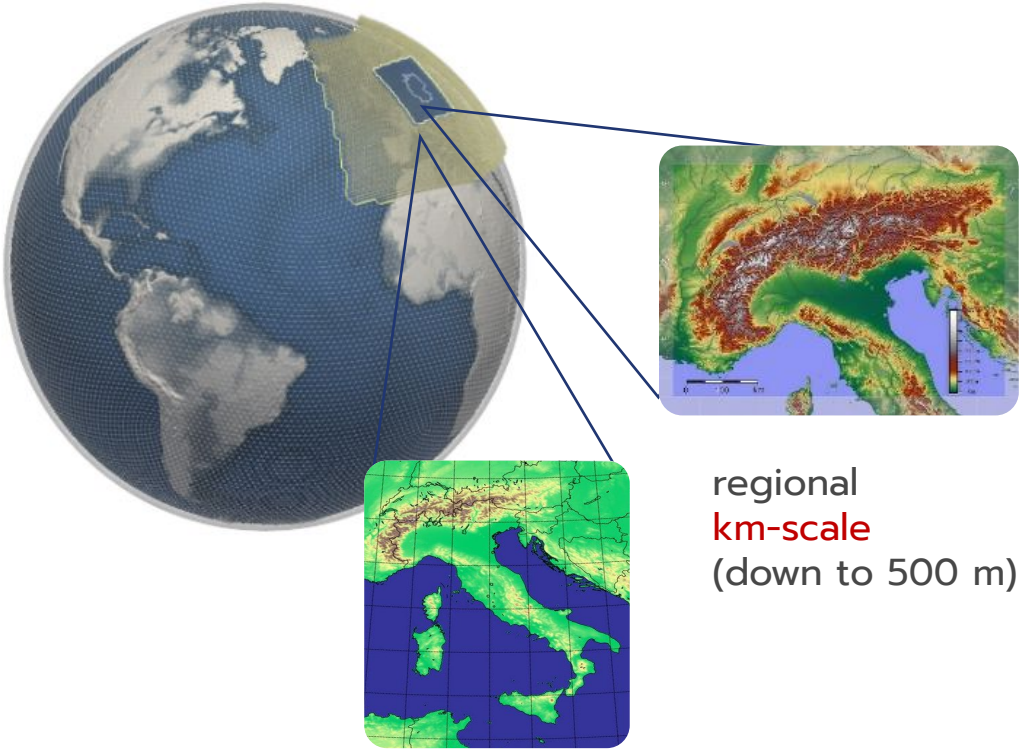
PrePEP Conference
16-21 March 2025
University of Bonn

The GLORI Digital Twin

GLObal to Regional | ICON Digital Twin

global storm-resolving (~3km)



regional
km-scale
(down to 500 m)

Tri-lateral Cooperation
Germany, Italy, Switzerland

Global-to-Regional short-range high resolution Digital Twin

configurable

on-demand

based on the prediction capability of the

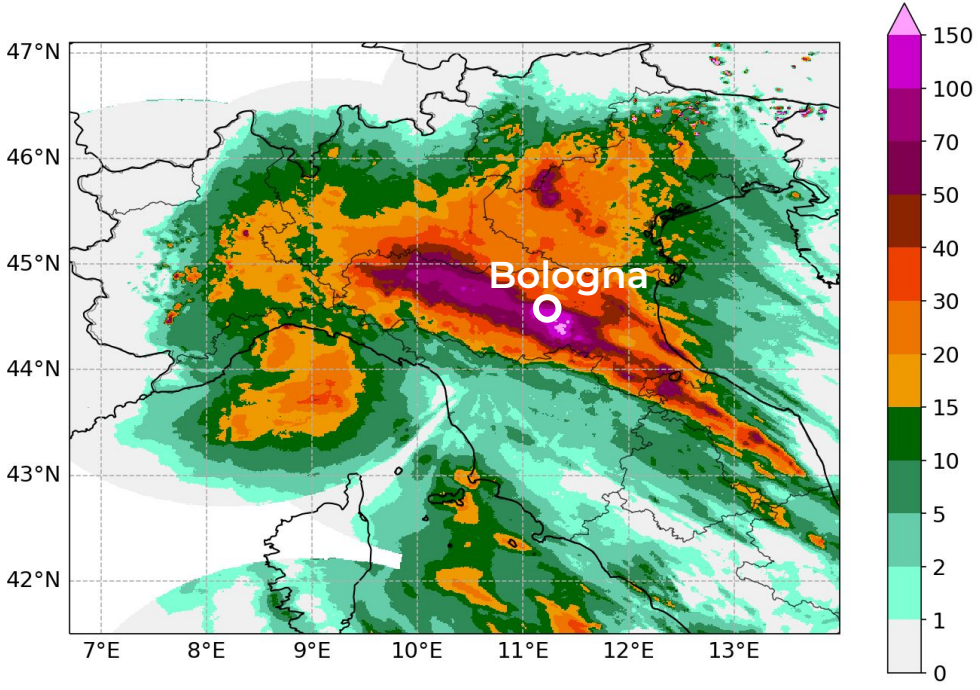
ICON modeling system

and the

Data Assimilation Coding Environment DACE

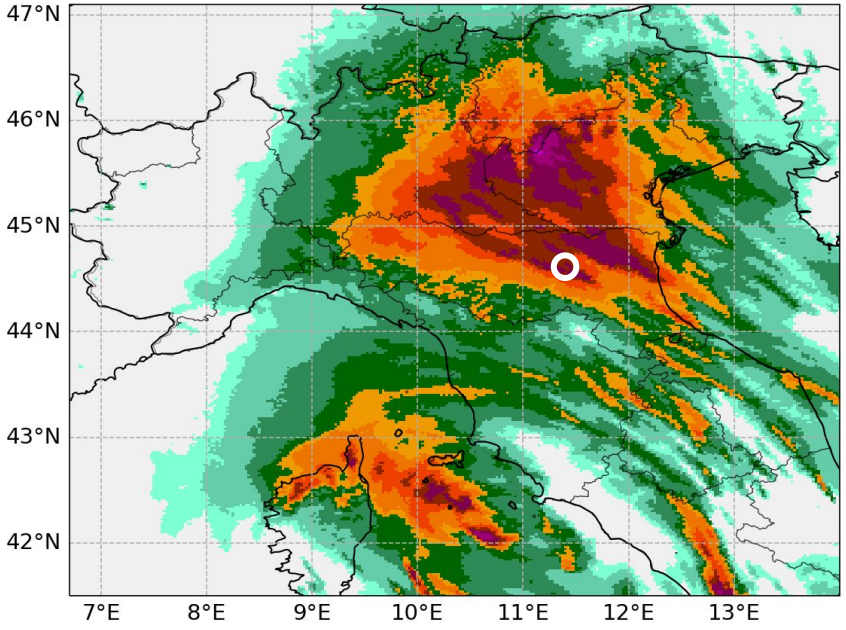
Bologna flood, 19/10/2024

Observed precipitation
from 19/10 at 12 UTC to 20/10 at 00 UTC



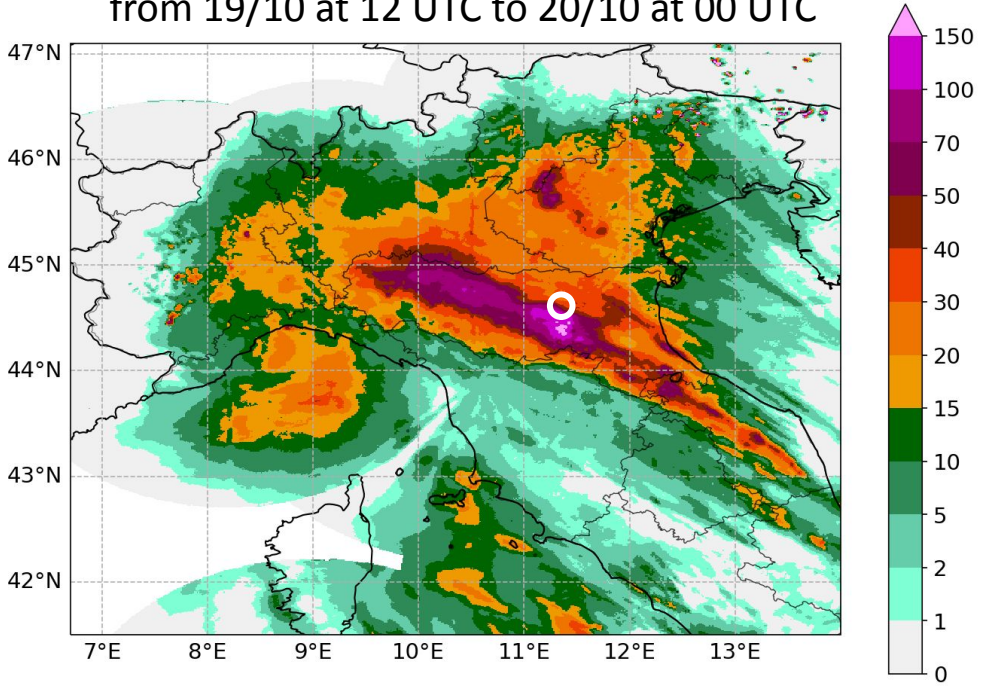
Bologna flood, 19/10/2024

ICON-2I forecast
initialized on 19/10 at 12 UTC



Forecast range: +0h to +12h

Observed precipitation
from 19/10 at 12 UTC to 20/10 at 00 UTC



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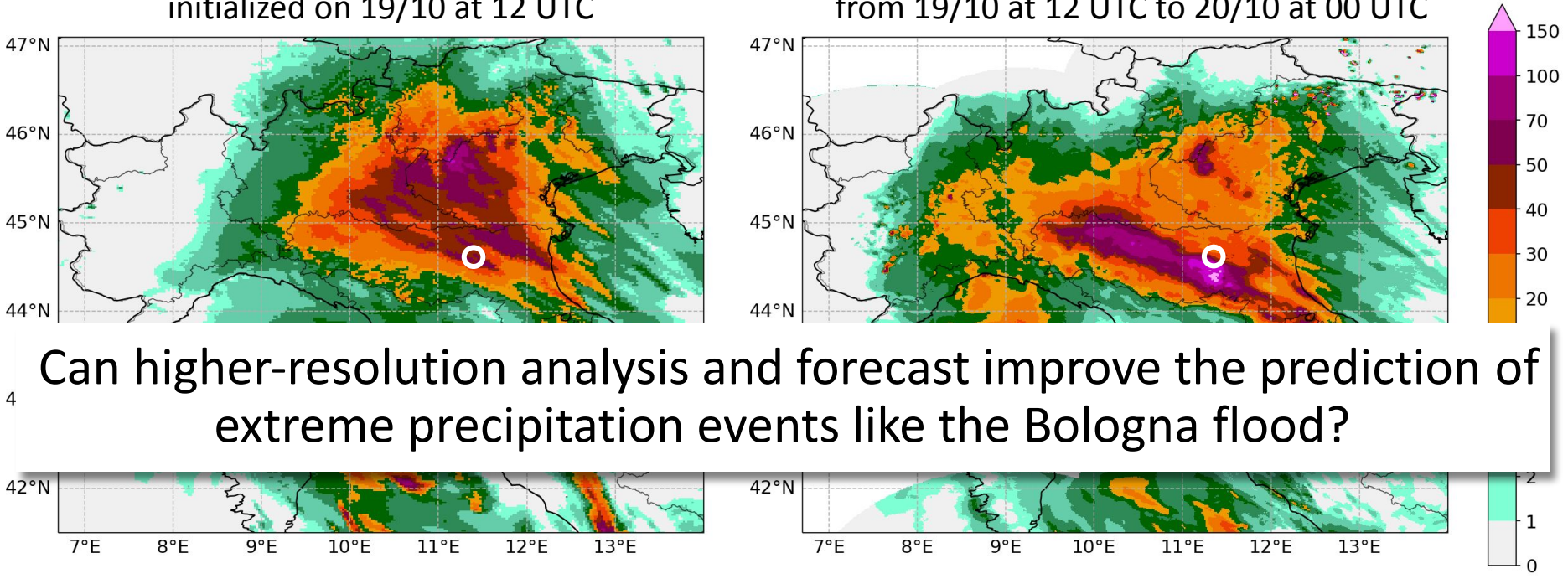
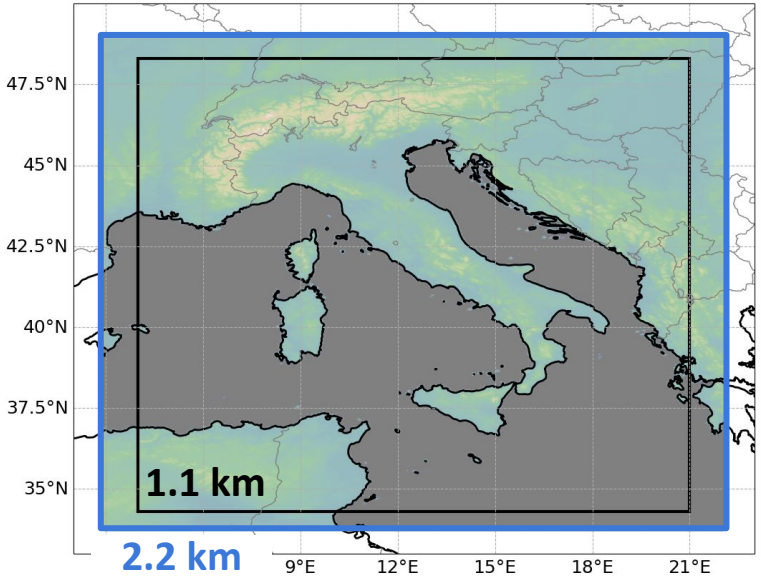


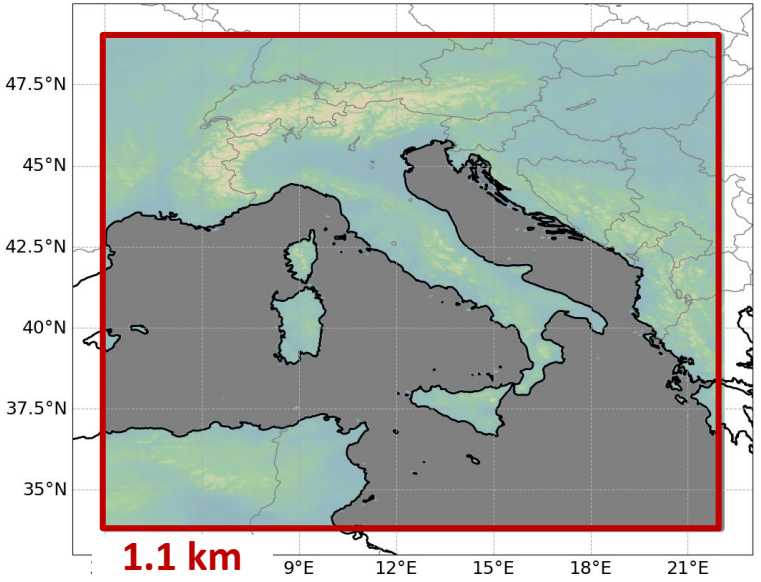
Can higher-resolution analysis and forecast improve the prediction of extreme precipitation events like the Bologna flood?

Experimental set-up

ICON-2I domains



ICON-1I domain



Model set-up for the two-way nesting (ICON-2I-NEST)

- Resolution: **2.2 km** and **1.1 km**, 65 levels
- Convection: only shallow convection parameterization (no grayzone tuning) for both domains

Experimental set-up

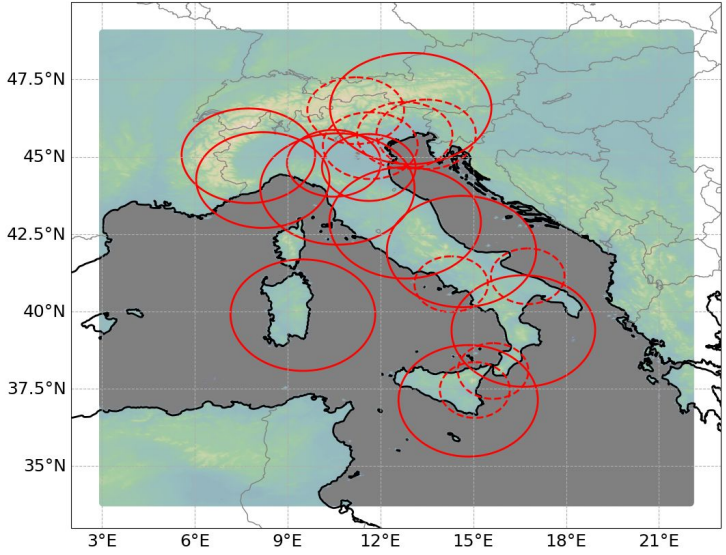
Evaluation of **four configurations** from 16 Oct 00 UTC to 20 October 00 UTC

Configuration	Analysis	Forecast	Description
control	ICON-2I	ICON-2I	Operational-like setup
nested_forecast	ICON-2I	ICON-2I-NEST	Uses *control* analysis but runs the forecast with 1.1 km nest
fully_nested	ICON-2I-NEST (first guess)	ICON-2I-NEST	Analysis and forecast computed with 1.1 km nest
run 1.1	ICON-2I	ICON-1I	Operational analysis at 2.2 km and forecast at 1.1 km

A 24-h deterministic forecast is initialized every 3h from the KENDA deterministic member (33 forecasts per configuration)

ICON-2I data assimilation system

ICON-2I domain



Model set-up:

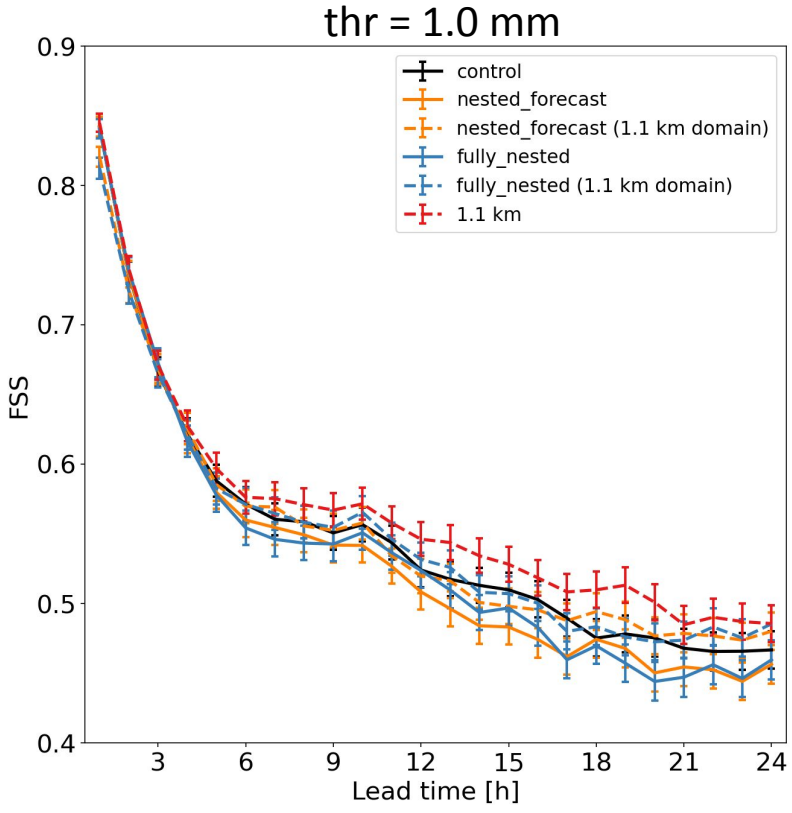
- Resolution: 2.2 km, 65 levels
- Convection: only shallow convection parameterization (no grayzone tuning)

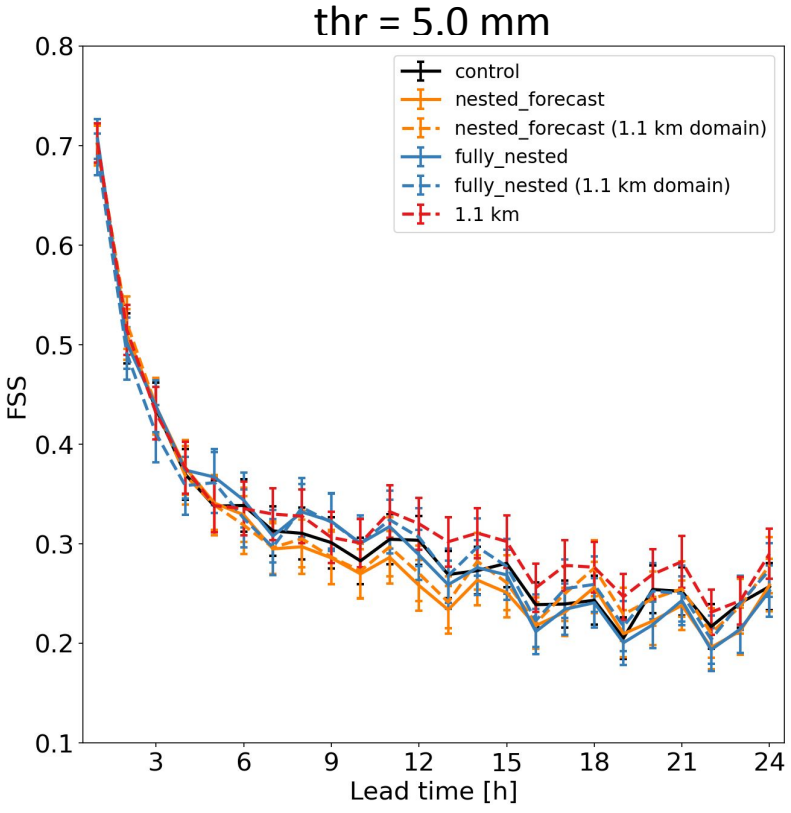
Data assimilation implementation (KENDA system):

- 40 members + deterministic run
- 1-h assimilation cycles, employing IAU
- Assimilation of AIREP, TEMP, SYNOP (wind and surface pressure) and weather radar volumes (solid lines) of reflectivity and radial wind through KENDA
- Assimilation of QPE based on Italian radar composite via LHN

QPF verification: FSS

Observations: hourly radar-estimated precipitation over Italy corrected with rain-gauges. Boxes: 0.2° x 0.2°



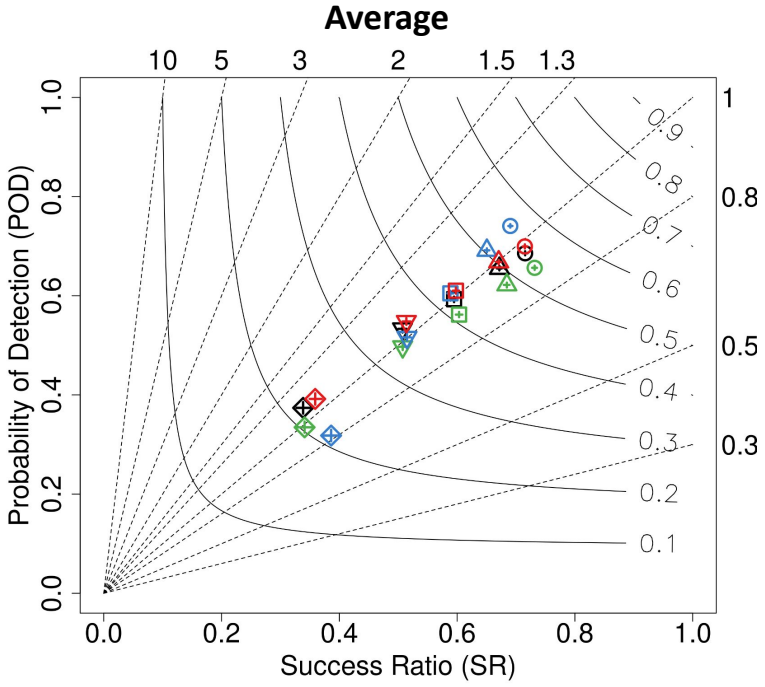


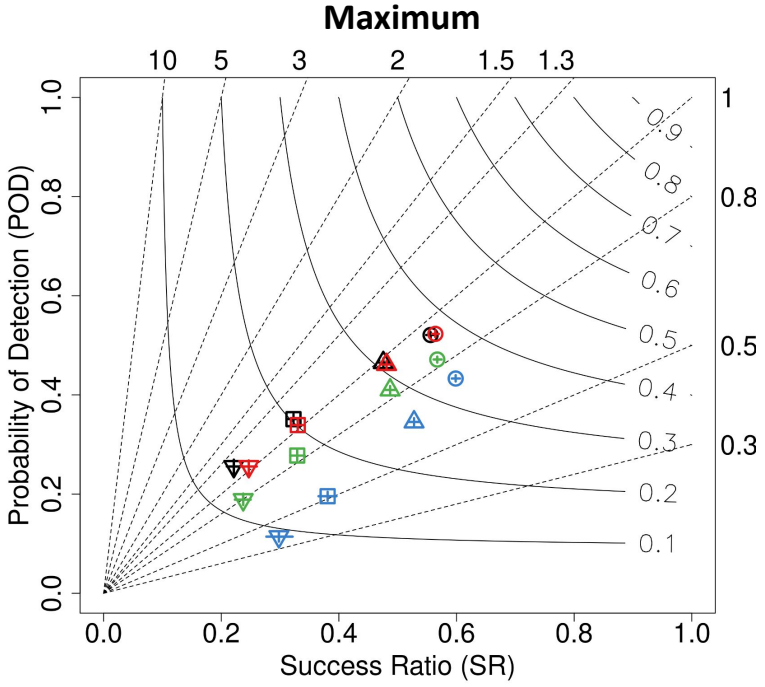
QPF verification: performance diagram

Verification setup:

- Evaluates average and maximum precipitation over alerting areas (regions homogeneous in terms of hydro-meteorological phenomena and impacts)
- ~ 3000 rain gauges
- Different precipitation thresholds for average and maximum values
- 1-hourly precipitation
- all lead times aggregated

QPF verification: performance diagram



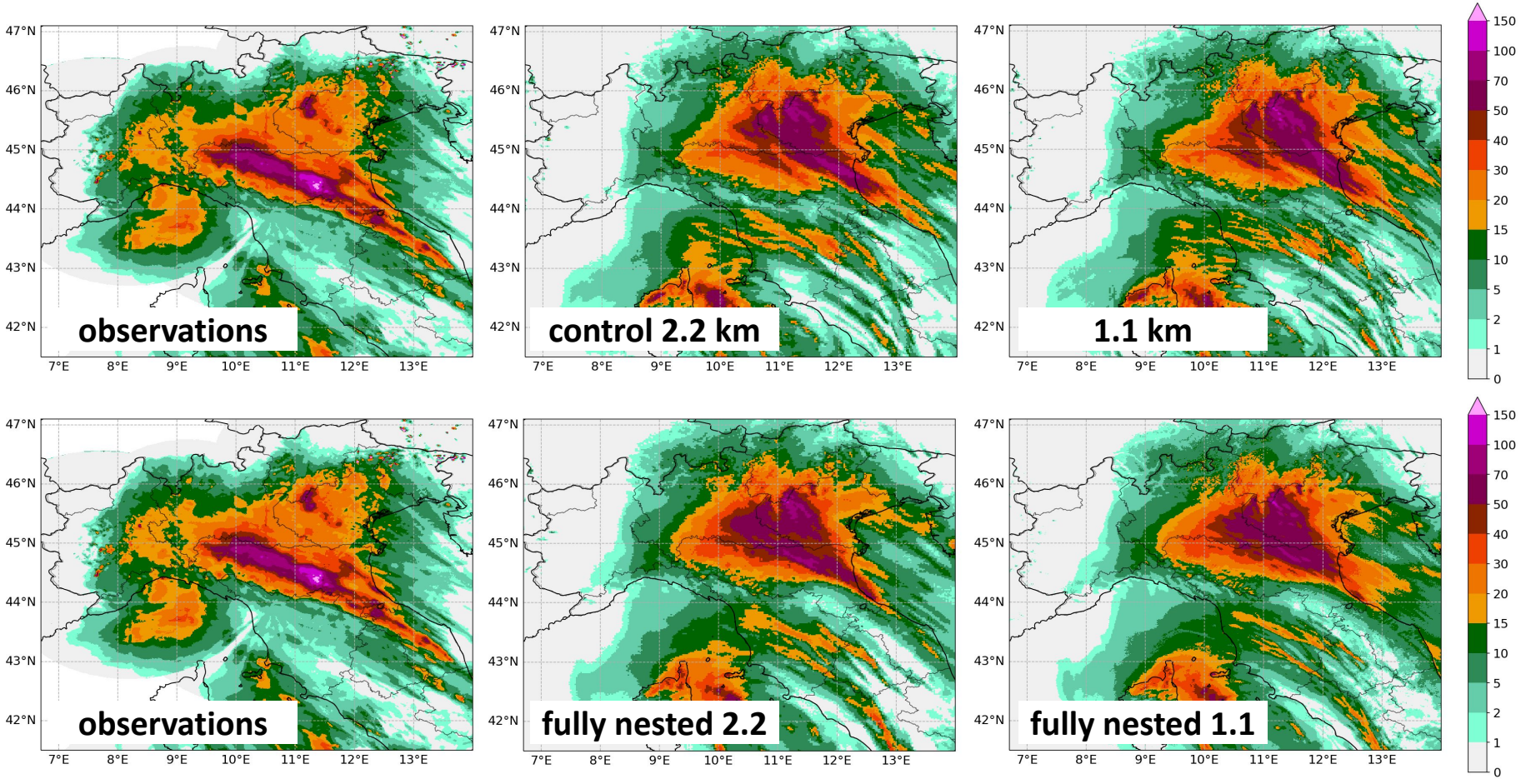


- thr = 0.1 mm
- thr = 0.2 mm
- thr = 0.5 mm
- thr = 1 mm
- thr = 3 mm

- control
- fully_nested
- fully_nested (1.1 km dom)
- 1.1 km

- thr = 3 mm
- thr = 5 mm
- thr = 10 mm
- thr = 15 mm

- control
- fully_nested
- fully_nested (1.1 km dom)
- 1.1 km


observations
control 2.2 km
1.1 km
observations
fully nested 2.2
fully nested 1.1
47°N
46°N
45°N
44°N
43°N
42°N
7°E
8°E
9°E
10°E
11°E
12°E
13°E
150
100
70
50
40
30
20
15
10
5
2
1
0

Conclusions and future plans

- Direct run at 1.1 km forecast shows slightly better performances in particular for rainfall maxima
- Precipitation misplacement still persists
- Increasing the resolution of the ICON model with two-way nesting for both forecasts and KENDA cycles degrades the performances

- Tuning parameterization schemes at 1.1 km
- Testing the whole system at 1.1 km, generating analysis at 1.1 km instead of 2.2 km
- Extending evaluation period considering different weather regimes
- Extending verification to other variables

Thank you for your attention